Emer Life Sci Res (2015) 1(1): 18-25

E-ISSN: 2395-6658
P-ISSN: 2395-664X

Research Article

Effect of Corm Size and Nitrogen on the Growth and Flowering of Gladiolus (Gladiolus grandiflorous L.)

Shahed Ahmed, Shamima Sultana, MD Abu Kawochar, Sauda Naznin, Fateh Un Tuli

Received: 26 February 2015, Accepted: 30 March 2015

Abstract

An experiment was conducted to evaluate the effect of corm size and nitrogen on the growth and flowering of gladiolus. The experiment considered with three corm sizes viz. small (11-20g), medium (21-30g) and large (31-40g) and four levels of nitrogen viz. 0, 80, 100 and 120 kg ha-1. Both corm size and nitrogen exhibited significant effect in almost all parameters studied. Considering the corm size, a gradual increasing trend in plant height, number of leaves plant-1 and length of leaves found with small to large sized corm. The highest length of flower stalk, length of rachis, number of floret spike-1, percentage of flowering plant and number of spike ha-1 were recorded in large sized corm. Considering the nitrogen fertilizer, the number of leaves plant-1 and width of leaves increased gradually with increasing nitrogen fertilizer. The highest length of flower stalk, rachis, number of floret spike-1, weight of single spike at harvest, percentage of flowering plant and number of spike ha-1 were recorded in the plot treated with 120 kg nitrogen ha-1. Considering the combined effect of corm size and nitrogen fertilizer, the highest length of flower stalk (76.53 cm), length of rachis (40.05 cm) at harvest, percentage of flowering plant (98.52%) and number of spike ha-1 (193920) was recorded from the plot of large sized corm with 120 kg nitrogen ha-1, whereas the lowest length of flower stalk (42.23 cm), rachis (19.67cm) percentage of flowering plant (56.64%) and number of spike ha-1 (145150) were recorded in the plot of small sized corm with no nitrogen. The highest net return (686845.2) and benefit cost ratio (2.464) were also obtained from the treatment combination of large sized corm and 120kg nitrogen ha-1.

Keywords Corm size, nitrogen, growth, flowering and Gladiolus grandiflorous L.

Introduction

Gladiolus (Gladiolus grandiflorous L.) belongs to the family Iridaceae and is a herbaceous perennial. It is now grown as cut flowers vary widely in the continent of Europe, particularly in Holland, Italy and Southern France (Butt 2005). It has gained popularity in many parts of the world owing to its unsurpassed beauty and economic value (Chadha and Choudhuary 1986). It is popular for its attractive spikes having florets of huge forms, dazzling colors, varying sizes and long keeping quality. Its spikes are most popular in flower arrangement and preparing high class bouquets (Mukhopadhayay 1995). In Bangladesh gladiolus was introduced around 1992 from India (Mollah et al. 2002). It was recently become popular in Bangladesh and its demand in this country is increasing day by day. Commercial cultivation of gladiolus is gaining popularity due to export potentials and prevalence of favorable growing condition in different parts of the country. Gladiolus is largely propagated by its corms and cormels. Reports indicated that the growth and flowering in gladiolus are affected by various factors of which size of corm is one of the main factors (Mohanty et al. 1994). The diameter and weight of corm greatly influence the yield and quality of cut flower in gladiolus. Increased flower production in case of larger corms (4.6-5.0 cm in diameter) has

S. Ahmed
Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agriculture University, Dhaka-1207, Bangladesh
S.Sultana✉, M.A. Kawochar, S.Naznin,
Tuber Crops Research Centre, Bangladesh Agricultural Research Institute, Gazipur
F.U.Tuli
Department of Pathology, Sher-e-Bangla Agriculture University, Dhaka-1207, Bangladesh
✉ shamimashanta123@gmail.com

been reported by Mukhopadhayay and Yadav (1984). Nitrogen plays an important role in building up protoplasm and protein, which induce cell division and initiate meristematic activities when applied in optimum quantity (Singh and Ramasingh 1969). It is one of the most important nutrients promoting yield and growth in gladiolus. The leaves should contain 2.5 to 3.0 percent or more nitrogen in dry weight for optimum yield (Bose and Yadav 1989). Nitrogen deficiency results in pale green coloration of foliage and reduction in the number of florets spike-1 and number of spikes corm-1 and also hampered to the utilization of food in old reserve (Woltz 1972). An optimum dose of the application of nutrient elements will not only ensure better yield and quality of gladiolus but also lead to minimum wastage of the nutrients. There is a scope of increasing flower yield, quality of flower, corm and cormel production of gladiolus with the appropriate size of corm and nitrogen. Under the agro-ecological conditions of Bangladesh, limited research work has been done on management practices of gladiolus. So, there is a lack of information regarding corm size and nitrogen fertilizer on the growth and flowering of gladiolus in Bangladesh. Considering the above facts the present investigation was undertaken to determine the growth and flowering performance of gladiolus under different combination of corm size and nitrogen.

Materials and Methods

The present experiment was carried out at the Horticulture farm of Sher-e-Bangla Agriculture University, Dhaka to investigate the effect of corm size and nitrogen on the growth and flowering of gladiolus in summer season. The experiment was considered with corm sizes viz. small (11-20g), medium (21-30g) and large (31-40g) and levels of nitrogen viz. 0, 80, 100 and 120 kg ha-1. The experiment was laid out in Randomized Complete Block Design with 3 replications. The size of the unit plot was 0.75m x 0.60m and corms were planted with spacing 20cm x 15cm. Standard production and cultural practicing packages were followed for raising healthy crops. Cow dung applied at 10 t ha-1. Nitrogen as urea fertilizer was applied as per treatments. Phosphorus as Triple Super Phosphate (TSP) and potash as Murate of Potash (MOP) fertilizers were applied at 225 kg ha-1 and 190 kg ha-1 respectively. The entire amount of cow dung and TSP was applied during final land preparation. Nitrogen was applied as top dressing as per treatment with 3 equal splits at 15, 30 and 45 days after germination. MOP was applied in two installments at 25 and 50 days after planting. Harvesting was done during 23 July to 16 August. Plant height (cm), number of leaves plant-1, length of leaves (cm) and width of leaves (cm) were recorded at 30, 45 and 60 days after planting (DAP).The data were also recorded for emergence of plant, length of spike at harvest (cm), length of rachis at harvest (cm), number of floret spike-1, weight of single spike (g), percentage of flowering plant (%) and number of spike ha-1 (‘000’). The recorded data of different parameters were statistically analyzed using MSTATC software. The means were adjudged by LSD test at 5% probability. The cost of production was analyzed in order to find out the most profitable treatment combination of corm size and nitrogen. All the nonmaterial and material input costs and interest on fixed and running capital were considered for estimating the cost of production. The interests were calculated 13% for each year.

Results and Discussion

Effect of corm size on growth and flowering of gladiolus

Corm size exhibited a significant influence on plant height, number of leaves plant-1, length and width of leaves, length of flower stalk, length of rachis, number of floret spike-1, percentage of flowering plant and number of spike ha-1, whereas, emergence of plant, number of leaves plant-1 and width of leaves at 60 days after planting (DAP) did not varied significantly (Figure 1 and Table1).A gradual increasing trend in plant height found with small to large size corm. At 60 DAP the significantly tallest plant (64.32 cm) was recorded in large sized corm, whereas the shortest plant (57.04 cm) was recorded in small sized corm. The results indicated that large sized corm produced the highest plant height for ensuring the supply of nutrient elements adequately to newly emergents. Singh (2000) found the tallest plants with larger corms. In case of number of leaves plant-1, a gradual increasing trend was showed for small to large sized of corm.Paswan and Hatibarua (2001) found more number of leaves from large corms. Length of leaves increased gradually with increasing size of corm. At 60 DAP the maximum length of leaves (55.48 cm) was produced from the

large size of corm while it was the minimum (48.94 cm) in small corm.Paswan and Hatibarua (2001) found the maximum leaf length in large and medium size of corms. This could be due to more food storage in larger corms.

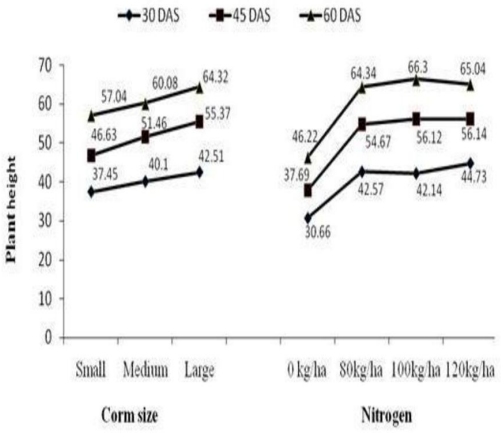

Fig.1. Main effect of corm size and nitrogen on plant height at different days after sowing of Gladiolus (LSD values were 1.49, 3.37 and 4.16 for the corm size and 1.72, 3.89 and 4.80 for nitrogen at 30, 45, 60 DAP respectively at 5% probability).

The highest length of flower stalk (68.17cm) at harvest was recorded in large sized corm while the lowest (61.01 cm) was recorded in small sized corm. This might be due to the use of higher amount of stored food material from larger corm. The highest length of rachis at harvest (33.82 cm) was recorded in large sized corm; on the other hand, the lowest length of rachis (28.98 cm) was recorded in small sized corm. Uddin (1998) found maximum rachis length in larger corms. The highest number of floret spike-1 (9.39) and weight of single spike (46.37g) were recorded in large sized corm, whereas the lowest number of floret spike-1 (7.13) and weight of single spike (35.42g) was recorded in small sized corm. The highest percentage (87.12%) of flowering plant was found in large sized corm when the lowest percentage (76.45%) was found in small sized corm. Similar results have also been reported by Singh and Singh (1998). The highest number of spike ha-1 (182670) was recorded in large sized corm, whereas the lowest number of spike ha-1 (164610) was recorded in small sized corm.

Effect of nitrogen on growth and flowering of gladiolus

Nitrogen exhibited significant influence on emergence of plant, plant height, number of leaves plant-1, length and width of leaves, length of flower stalk, length of rachis, number of floret spike-1, weight of single spike, percentage of flowering plant and number of spike ha-1 (Figure 1 and Table 2).
The minimum number of days (12.67) required for emergence was recorded in plot treated with 80 kg nitrogen ha-1 and the maximum (21.44) was recorded in plot with no nitrogen. The tallest plant (66.30cm) at 60 DAP performed in the plot treated with 100 kg nitrogen ha-1, on the other hand, the shortest plant (46.22 cm) performed in the plot treated with no nitrogen. Baweza (2003) reported similar result. The number of leaves plant-1 increased with the increasing amount of nitrogen fertilizer. The maximum number of leaves plant-1 (6.18) at 60 DAP was found in the plot treated with 120 kg nitrogen ha-1 which was statistically identical to that of 80 and 100 kg nitrogen ha-1. In case of length of leaves at 60 DAP, the highest (59.36 cm) was obtained from plot treated with 120 kg nitrogen ha-1, whereas the lowest (38.18 cm) was obtained from control plot. The width of leaves increased gradually with increasing of nitrogen.

The highest length of flower stalk (73.22 cm) at harvest was recorded in the plot treated with 120 kg nitrogen ha-1 while the lowest (42.93 cm) was recorded in the plot with no nitrogen. Considering the length of rachis at harvest, the highest length (36.46 cm) was found in the plot treated with 120 kg nitrogen ha-1, whereas the lowest length (20.78 cm) was found in the plot treated with no nitrogen. Ullah (2006) reported similar result. The highest number of floret spike-1 (9.81) was recorded in the plot treated with 120 kg nitrogen ha-1 which was followed by that of 100 kg nitrogen ha-1 (9.55) and the lowest number of floret spike-1 (4.93) was recorded in the plot treated with no nitrogen. Bijimol and Singh (2001) reported that the number of floret spike-1 increased with the increase of nitrogen. The highest weight of single spike (52.51 g) was recorded in the plot with 120 kg nitrogen ha-1. The highest percentage of flowering plant (96.04%) was found in the plot treated with 120 kg nitrogen ha-1.

emergent

Table 1. Main effect of corm size on growth and flowering of Gladiolus

Treatments	Emergence of plant	Number of leaves plant^{-1}			Length of leaves (cm)			Width of leaves (cm)			Length of Spike at harvest (cm)	Length of rachis at harvest (cm)	No. Of floret spike^{-1} at harvest	Wt. Of Single spike at harvest (g)	Percentage of flowering plant (%)	No. Of Spike ha^{-1} ('000')
		30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP						
Corm size																
Small	16.58	3.40	4.72	5.65	28.18	37.90	48.94	2.83	3.06	3.34	61.01	28.98	7.13	35.42	76.45	164.61
Medium	14.67	3.61	4.98	5.87	30.62	39.37	53.42	3.22	3.40	3.53	64.52	32.24	8.61	45.52	79.12	174.95
Large	15.50	3.66	5.18	5.93	32.03	43.67	55.48	3.22	3.46	3.47	68.17	33.82	9.39	46.37	87.12	182.67
LSD at 5%	2.28	0.19	0.33	0.41	1.59	2.42	3.99	0.28	0.22	0.21	4.16	3.95	0.92	4.07	3.06	3.658
Levels of significance	NS	*	*	NS	*	*	*	*	*	NS	*	*	*	*	*	*

* Significant at 5% level of probability

Table 2. Main effect of nitrogen fertilizer on growth and flowering of Gladiolus

Treatments	Emergence of plant	Number of leaves plant^{-1}			Length of leaves (cm)			Width of leaves (cm)			Length of Spike at harvest (cm)	Length of rachis at harvest (cm)	No. Of floret spike^{-1} at harvest	Wt. Of Single spike at harvest (g)	Percentage of flowering plant (%)	No. Of Spike ha^{-1} ('000')
		30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP						
Nitrogen																
0 kg/ha	21.44	3.07	4.23	4.81	24.34	31.09	38.18	2.27	2.54	2.70	42.93	20.78	4.93	22.89	61.53	153.99
80kg/ha	12.67	3.70	5.36	6.14	32.28	42.21	55.26	3.22	3.43	3.54	70.26	34.17	9.21	48.72	74.58	169.87
100kg/ha	14.22	3.50	5.06	6.13	30.99	43.71	57.67	3.12	3.39	3.58	71.85	35.32	9.55	45.63	91.42	182.79
120kg/ha	14.00	3.96	5.20	6.18	33.49	44.26	59.36	3.74	3.87	3.96	73.22	36.46	9.81	52.51	96.04	190.03
LSD at 5%	2.64	0.22	0.39	0.48	1.83	2.79	4.61	0.32	0.25	0.25	4.80	4.56	1.07	4.70	3.53	4.224

* Significant at 5% level of probability

The lowest percentage (61.53%) of flowering plant was found in the plot treated with no nitrogen.

This huge variation might be caused due to no supply of nitrogen during flower initiation which is an essential element for development. The highest number of spike ha-1 (190090) was recorded in the plot treated with 120 kg nitrogen ha-1, whereas the lowest number of spike ha-1 (153990) was recorded in the plot with no nitrogen.

Combined effect of corm size and nitrogen on the growth and flowering of gladiolus

Combined effect of corm size and nitrogen was found to be significant in case of emergence of plant, plant height, number of leaves plant-1, length and width of leaves, length of flower stalk, length of rachis, number of floret spike-1, weight of single spike, percentage of flowering plant and number of spike ha-1 (Figure 2 and Table 3).

The minimum number of days (11.67) required for emergence of plant was recorded in the plot of medium size corm with 80 kg nitrogen ha-1, whereas the maximum (21.67) was recorded in the plot of large and medium sized corm with control does of nitrogen. The tallest plant (71.87 cm) at 60 DAP was recorded in the plot of large sized corm with 100 kg nitrogen ha-1 and the shortest plant (29.83 cm) were recorded in the plot of small sized corm with no nitrogen. The maximum number of leaves plant-1 (6.57) at 60 DAP was recorded from medium sized corm with 80 kg nitrogen ha-1. The maximum length of leaves (63.37 cm) was produced in the plot of large sized corm with 120 kg nitrogen ha-1 while it was the minimum (37.73 cm) in the plot of small sized corm with control dose of nitrogen. The maximum width of leaves (4.00 cm) at 60 DAP was found in the plot of large sized corm with 120 kg nitrogen ha-1 and the minimum (2.57 cm) was found in the plot of small sized corm with control dose of fertilizer.

The highest length of flower stalk (76.53 cm) at harvest was recorded in the plot of large sized corm with 120 kg nitrogen ha-1, whereas, the lowest length of flower stalk (42.23 cm) was recorded in plot of small sized corm with no nitrogen. The highest length of rachis at harvest (40.05 cm) was recorded in plot of large sized corm with 120 kg nitrogen ha-1 and the lowest length of rachis (19.67cm) was recorded in plot of small sized corm with no nitrogen. The highest number of floret spike-1 (11.32) was recorded in the plot of medium sized corm with 120 kg nitrogen ha-1 and the lowest number of floret spike-1 (4.83) was recorded in small sized corm with no nitrogen. The highest weight of single spike (63.50 g) was recorded in large sized corm with 120 kg nitrogen ha-1. The highest percentage of flowering plant (98.52%) was recorded in the plot of large sized corm with 120 kg nitrogen ha-1 and the lowest percentage (56.64%) flowering plant was recorded in the plot of small sized corm with no nitrogen. The highest number of spike ha-1 (193920) was recorded in the plot of large sized corm with 120 kg nitrogen ha-1 which was followed by that of large sized corm with 100 kg nitrogen ha-1 and medium sized corm with 120 kg nitrogen ha-1. The result suggested that nitrogen significantly associated with the weight of corm in flower production. However, the lowest number of spike ha-1 (145150) was recorded in small sized corm with no nitrogen.

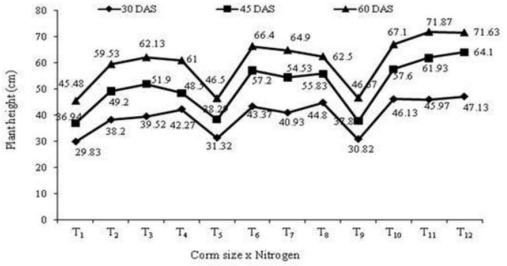

Fig.2. Combined effect of corm size and nitrogen on plant height at different DAP (LSD values are 2.97, 6.74 and 8.31 at 30, 45 and 60 DAP respectively at 5% probability).

[T1:Small + 0 Kg N ha-1; T2: Small + 80 Kg N ha-1; T3: Small + 100 Kg N ha-1; T4: Small + 120 Kg N ha-1; T5: Medium + 0 Kg N ha-1; T6: Medium + 80 Kg N ha-1; T7: Medium + 100 Kg N ha-1; T8: Medium + 120 Kg N ha-1; T9: Large + 0 Kg N ha-1; T10: Large + 80 Kg N ha-1; T11: Large + 100 Kg N ha-1; T12: Large + 120 Kg N ha-1]

Table 3. Combined effect of corm size and nitrogen on growth and flowering of Gladiolus

Corm size × Nitrogen (kg ha-1)		Days required for emergence of plant	Number of leaves plant-1			Length of leaves (cm)			Width of leaves (cm)			Length of spike at harvest (cm)	Length of rachis at harvest (cm)	No. of floret spike-1 at harvest	Weight of single spike (g)	Percentage of flowering plant (%)	No. of spike ha-1 ('000')
			30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP	30 DAP	45 DAP	60 DAP						
Small	0	21.00	3.01	4.10	4.73	24.01	30.98	37.73	2.17	2.47	2.57	42.23	19.67	4.83	22.33	56.64	145.15
	80	13.67	3.57	5.27	5.90	28.53	39.23	51.30	2.97	3.25	3.45	67.25	33.33	9.08	40.33	62.48	155.47
	100	16.67	3.27	4.57	5.80	28.27	41.13	54.93	2.77	3.10	3.43	66.23	31.25	7.58	40.33	91.01	172.82
	120	15.00	3.77	4.93	6.17	31.90	40.23	51.80	3.40	3.43	3.90	68.33	31.67	7.00	38.67	95.65	185.00
Medium	0	21.67	3.04	4.20	4.80	24.33	31.14	37.90	2.33	2.57	2.73	43.03	21.33	4.90	23.33	60.33	153.81
	80	11.67	3.93	5.50	6.57	34.13	40.58	56.37	3.60	3.73	3.83	67.37	30.08	8.37	53.50	71.56	168.86
	100	13.00	3.53	5.27	6.20	30.00	41.83	56.50	3.20	3.43	3.57	72.88	39.89	9.86	49.90	90.63	187.14
	120	12.33	3.93	4.97	5.90	34.00	43.93	62.90	3.77	3.87	3.97	74.80	37.68	11.32	55.35	93.95	189.98
Large	0	21.67	3.17	4.40	4.90	24.68	31.14	38.90	2.30	2.60	2.80	43.53	21.33	5.07	23.00	67.62	163.02
	80	12.67	3.60	5.30	5.97	34.17	46.80	58.10	3.10	3.30	3.33	76.17	39.08	10.17	52.33	89.70	185.30
	100	13.00	3.70	5.33	6.40	34.70	48.15	61.57	3.40	3.63	3.73	76.44	34.82	11.22	46.65	92.63	188.42
	120	14.67	4.17	5.70	6.47	34.57	48.60	63.37	4.07	4.30	4.00	76.53	40.05	11.11	63.50	98.52	193.92
LSD at 5%		4.57	0.38	0.67	0.83	3.18	4.84	7.99	0.38	0.55	0.44	8.31	7.90	1.85	8.15	6.11	7.316
Leaves of significance		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* Significant at 5% level of probability

Table 4. Cost and return analysis of gladiolus considering the effect of corm size and nitrogen on Gladiolus

Corm size × Nitrogen (kg ha-1)		Gross return (Tk. ha-1)	Total cost of production (Tk. ha-1)	Net return (Tk. ha-1)	Benefit cost ratio (BCR)
Small	0	725750	276127.9	484924.2	1.756
	80	777350	277779.9	534872.2	1.925
	100	864100	278251.9	621150.2	2.232
	120	925000	278723.9	681578.2	2.445
Medium	0	769050	276127.9	508557.1	1.841
	80	844300	277779.9	582155.1	2.095
	100	935700	278151.9	673083.1	2.418
	120	949900	278723.9	686811.1	2.464
Large	0	815100	276127.9	534941.2	1.937
	80	926500	277779.9	644689.2	2.320
	100	942100	278251.9	659817.2	2.371
	120	969600	278723.9	686845.2	2.464

(N. B. Tk. 5.00 spike-1; 1$ equal to Tk. 78)

Economic analysis

Economic analysis was done to find out the profitable performer (Table 4). In the combination of corm size and nitrogen, the highest gross return (Tk. 969600) was obtained from the combination of large sized corm and 120 kg nitrogen ha-1 and the second highest gross return (Tk. 949900) was obtained from the combination of medium sized corm and 120 kg nitrogen ha-1, whereas, the lowest gross return (Tk. 725750) was obtained from the combination of small sized corm with no nitrogen. In case of net return, the highest net return (Tk. 686845.2) was obtained from the combination of large sized corm with 120 ka nitrogen ha-1 and the second highest net return (Tk. 686811.1) was obtained from the treatment of medium sized corm with 120 ka nitrogen ha-1, whereas, the lowest net return (Tk. 484924.2) was obtained from the combination of the small sized corm with no nitrogen fertilizer. In case of benefit cost ratio (BCR), the highest BCR (2.464) was attained from the treatment of large sized corm with 120 kg nitrogen ha-1 and the second highest benefit cost ratio (2.464) was estimated from the treatment of medium sized corm with 120 kg nitrogen ha-1. The lowest (1.756) benefit cost ratio was obtained from the treatment of small sized corm with no nitrogen.

Conclusion

The large size of corm (31-40g) and 120 kg nitrogen ha-1 each was found to be best in respect of plant growth and flowering. Thus, combination of large sized corm (31-40g) and 120 kg nitrogen ha-1 was also found to be the best for the growth and production of flower of gladiolus and was profitable. Further study need to be conducted with different level of nitrogen ha-1 to get exclusive result regarding nitrogen fertilizer.

Acknowledgements

The author expresses his deep sense of gratitude to Bangladesh Agricultural Research Institute (BARI), Bangladesh for their help in supplying the seed, information and sharing the knowledge. The author also thanks to all staffs of Department of Horticulture of Sher-e-Bangla Agriculture University, Dhaka, Bangladesh. It was a part of MS research works.

References

A. Mukhopadhayay (1995). Gladiolus, Publication and Information Division, ICAR New Delhi. p. 35.

C.R. Mohanty, D.K. Saha and R.C. Das (1994). Studies on the effect of corm sizes and preplanting chemical treatment of corms on

growth and flowering of gladiolus. Orissa J. Hort., 22:1-4.

G. Bijimol and A.K. Singh (2001). Effect of spacing and N on flowering, flower quality and postharvest life of gladiolus. Indian J. Appl. Hort., 3: 48-50.

H.S. Baweza (2003). Effect of corm size and N level on growth and flowering of gladiolus under mid hill condition of Himachal Pradesh. Sco. Hort., 8:187-189.

K.L. Chadha and B. Chowdhury (1986). Ornamental Horticulture in India. Publication and information. India. Council of Agriculture Research, New Delhi. 86-103.

K.P. Singh (2000). Growth, flowering and corm production in gladiolus as affected by different corms. J. Ornamental Hort., 3: 26-29.

L. Paswan and Hatibarua (2001). Effect of fractionated and different grade sizes of corm on the corm and cormel production of gladiolus. J. Agril. Sci. Soc.,14: 5-10.

M.A. Ullah (2006). Effect of nitrogen and spacing on growth, flowering, corm and cormel production of gladiolus. (MS Thesis), Department of Horticulture, Bangladesh Agriculture University, Mymensingh, Bangladesh.

M.F. Singh and S.M. Ramasingh (1969). Response of onion to different fertilizer application. Indian J. Agric. Sci., 39: 1026-1028.

M.R. Uddin (1998). Effects of spacing, corm and cormel size on growth, flowering, corm and cormel production of gladiolus. (MS Thesis), Department of Horticulture, Bangladesh Agriculture University, Mymensingh, Bangladesh.

M.S. Mollah, F.N. Khan and M.M. Amin (2002). Gladiolus. Landscape, Ornamental and Floriculture Division. H.R.C, BARI. Gazipur, Bangladesh.

S. Singh and S. Singh (1998). Effect of corm size on flowering and corm production of gladiolus. J. Ornamental Hort., 1: 79-80.

S.G. Butt (2005). Effect of N, P, K on Some Flower Quality and Corm Yield Characteristics of Gladiolus. J. of TekirdaghAgril. Faculty., 2: 212-214.

S.S. Woltz (1972). The world of the gladiolus, NAGC, USA, pp. 143-149.

T.K. Bose and L.P. Yadav (1989). Gladiolus. In: Commercial Flowers. T. K. Bose and L. P. Yadav (Eds.). NayaProkash, Calcutta-7, India. p.267.

T.K. Mukhopadhayay and L.P. Yadav (1984). Effect of corm size and spacing on growth, flowering and corm production of gladiolus. Haryana J. Hort. Sci., 13: 95-99.